

# **Chapter 24**

## **Explosives**

**January 1997**

**Approved by the ES&H Working Group**

\_\_\_\_\_  
**Robert Kuckuck**  
**Deputy Director for Operations**

date \_\_\_\_\_

## 24

# Explosives\*

## Contents

24.1	Introduction .....	24-1
24.2	Applicability .....	24-1
24.3	Regulatory Requirements .....	24-1
24.4	Reducing Risk .....	24-1
24.4.1	Safety and Operating Procedures .....	24-1
24.4.2	Working with Explosives .....	24-2
24.4.3	Storing Explosives .....	24-6
24.4.4	Laboratory-Scale Operations with Explosives .....	24-8
24.4.5	Operations and Materials that Require Special Controls .....	24-8
24.4.6	Procurement of Explosives .....	24-12
24.4.7	Shipping, Transferring, and Transporting Explosives .....	24-12
24.4.8	Use of Electrical Equipment .....	24-13
24.4.9	Explosives Waste Management .....	24-14
24.4.10	Hazardous Work Permits .....	24-15
24.4.11	Emergencies .....	24-15
24.4.12	Process Safety Management .....	24-16
24.5	Responsibilities .....	24-16
24.5.1	Managers .....	24-16
24.5.2	Qualified Explosives Handlers .....	24-17
24.5.3	ES&H Teams .....	24-17
24.5.4	Hazards Control Explosives Safety Personnel .....	24-17
24.5.5	Procurement Department .....	24-18
24.5.6	Materials Management Section .....	24-18
24.5.7	C&MS Energetic Materials Section .....	24-18
24.5.8	LLNL Explosive Safety Committee .....	24-18
24.5.9	Hazardous Waste Management Division .....	24-18
24.5.10	Health Services Department .....	24-19
24.5.11	Mechanical Engineering Department .....	24-19
24.6	Training and Qualification of Explosive Users .....	24-19
24.6.1	Initial Qualification .....	24-19
24.6.2	Medical Clearance and Surveillance .....	24-19
24.6.3	Annual Review .....	24-19
24.6.4	Suspension of Qualification .....	24-20
24.6.5	Age Restrictions .....	24-20
24.7	LLNL Contacts .....	24-20
24.8	References and Supporting Standards .....	24-20

## **Appendices**

Appendix 24-A	Explosives by Storage Compatibility/Handling Control	
	Category .....	24-21
Appendix 24-B	Reclassification of Explosives .....	24-27
Appendix 24-C	Explosives Handling Review, Stability Review, and Shipping Data Form .....	24-29

## **List of Supplements**

24.05	Shipping, Transferring, and Transporting Explosives
24.09	Low-Energy Initiator (LEI) Controls
24.11	Adhesives, Fillers, and Coatings Used with Explosives
24.15	Electrical Instruments for Use with Explosives Systems
24.30	Response Plan for Fire in an Explosives Area

## **24 Explosives**

### **24.1 Introduction**

Because serious consequences can occur if explosives are handled improperly, it is LLNL policy that no operation involving explosives may be conducted unless it is authorized by a safety procedure. In addition, persons handling or transporting explosives must be qualified to perform their work by completing the appropriate training.

This chapter provides guidance for implementing the requirements in the *DOE Explosives Safety Manual* as well as procedures necessary for ensuring the safety of operations involving explosives. Both the *DOE Explosives Safety Manual* and this chapter describe the LLNL Explosives Safety Program and basic controls for reducing the risk of an explosives accident.

### **24.2 Applicability**

This chapter applies to LLNL operations involving explosives at the LLNL-Livermore site and Site 300. Although Site 300 was established as the designated explosives processing and testing area for LLNL, some experimental work involving smaller quantities of explosives is permitted in various facilities at the LLNL-Livermore site. The High Explosives Applications Facility (HEAF) is the main explosives research facility at the LLNL-Livermore site.

### **24.3 Regulatory Requirements**

The DOE required standard for explosives operations and facilities is the *DOE Explosives Safety Manual*, DOE M 440.1-1 (formerly DOE/EV/06194).

Section 24.4.4 (Laboratory-Scale Operations with Explosives) of this chapter describes the applicability of the requirements in the *DOE Explosives Safety Manual* to LLNL research and development laboratory-type operations.

### **24.4 Reducing Risk**

#### **24.4.1 Safety and Operating Procedures**

Safety procedures that apply the LLNL *Health & Safety Manual* and *DOE Explosives Safety Manual* are contained in the various facility safety procedures (FSPs) and operational safety procedures (OSPs). Each explosives facility conducts its normal operations within the scope of a safety procedure specifically written for the operations of a particular building, group of facilities with like operations and hazards, or other work area. If a proposed explosives operation is not covered by an FSP, then the new activity must be reviewed and authorized

by an OSP, as specified in Supplement 2.02 of the *Health & Safety Manual*, before work can begin.

In addition to the general requirements described in this supplement, safety procedures involving explosives must also include

- The quantity-distance assessment for the facility or work area.
- A description of the United Nations Organization (UNO) Hazard Class/Division of the explosives authorized.
- Personnel limits for the work area.
- Explosives limits.
- Any special emergency actions or response procedures that may be relevant.

The supervisor of the operation, while responsible for preparing the safety procedure, can obtain advice and assistance from the Hazards Control ES&H team supporting the area. The responsible person should contact the ES&H team as soon as possible to ensure that all requirements are included during the planning phase.

All safety-related operating procedures involving explosives (i.e., OSPs and FSPs) are required to be reviewed annually by the responsible person and Hazards Control Explosives Safety to determine if any new safety controls are necessary. If the procedure is no longer completely applicable to the operation, or if new safety considerations (e.g., compatibility, toxicity, ignition sources) have been identified, the procedure must be revised.

#### **24.4.2 Working with Explosives**

**General Requirements.** Most explosives work has a potential for serious injury. If the explosives operation presents an unacceptable risk for personnel exposure, then personnel must be separated from the explosives by an appropriate distance or by an adequate protective barrier. This type of work is called a Remote Operation. If the explosives work presents a low risk of detonation or fire, then personnel may perform the work “hands on” in the presence of the explosive. This type of work is called a Contact Operation. Hazards Control Explosives Safety personnel provide guidance on the controls necessary for both Remote and Contact Operations.

The safety procedure that authorizes an explosives operation must describe the hazards of the explosives work area and the controls that must be applied. In addition, the following guidelines apply to all explosives work areas:

- Use the minimum amount of explosives necessary for the operation. The posted weight limit for an area is a maximum and must never be exceeded.
- Limit and keep to a minimum the number of personnel involved in an explosives operation.

- Repair and service all equipment and apparatus as outlined by the maintenance standards for the facility.
- Remove all explosives from the work area and put them either in a magazine or an approved safe file, vault, or cubicle during maintenance work that requires open flames or welding.
- Post safety warning signs near all entryways to the explosives area.
- Ensure that all personnel who handle explosives are trained and qualified as outlined in Section 24.6.
- Use suitable eye protection when working or visiting in eye-hazard areas, particularly when electro-explosive devices are being handled. The explosives operation shall be evaluated for eye-hazard risks.
- Control electrical meters and other electrical instruments used with explosives systems as outlined in Supplement 24.15 of the *Health & Safety Manual*.
- Store equipment in an approved storage location. Equipment must be cleaned to remove explosives contamination before storage or shipment to another area.
- Develop a method for regularly collecting and removing waste and material contaminated with explosives. This method must be stated in the controlling safety procedure.
- Keep explosives work areas clean and reasonably neat. Clean up explosives spills as they occur.
- Handle explosives carefully. Do not throw, drop, tumble, or drag them. Such rough handling creates shock and friction which can result in fire or detonation.
- Package explosives to be moved with adequate padding.
- Prohibit smoking and open flames wherever explosives may be found.

**Explosives Hazard Classification System .** LLNL has converted to the UNO hazard classification system for classifying explosive materials and explosive components. The UNO system is recognized internationally and has been used by the Department of Defense and other DOE contractors for many years. The Department of Transportation (DOT) has also converted to this system, creating a single universal system.

The UNO system consists of nine classes of dangerous goods, with explosives making up Class 1. The explosives hazard class is further subdivided into six divisions, which are used for segregating ammunition and explosives on the basis of similarity of characteristics, properties, and accident effects potential. These six divisions are described in Table 24-1.

**Table 24-1. Explosives hazard/class divisions.**

<b>Hazard class/division</b>	<b>Hazard description</b>
<b>1.1</b>	<b>Mass explosion</b>
<b>1.2</b>	<b>Nonmass explosion, fragment producing</b>
<b>1.3</b>	<b>Mass fire, minor blast or fragment</b>
<b>1.4</b>	<b>Moderate fire, no blast or fragment</b>
<b>1.5</b>	<b>Explosive substance, very insensitive (with a mass explosion hazard)</b>
<b>1.6</b>	<b>Explosive article, extremely insensitive</b>

Under the UNO system, 13 storage compatibility groupings further categorize Class 1 explosives by their form or composition, ease of ignition, and sensitivity to detonation. Because it is unlikely that several of the explosive articles in these groupings (e.g., napalm and explosive chemical weapons) will ever be used or stored at DOE facilities, the DOE has modified this system by deleting groups H, J, K, and N, thus reducing the storage compatibility groupings in use from 13 to 9.

At LLNL, these nine storage compatibility groups are also used for the handling system that controls the group of explosives permitted in an approved explosives work area. Appendix 24-A contains a listing of the more common explosives that can be found at LLNL. Each storage compatibility/handling control (SC/HC) group in use at LLNL is described below with examples:

- **SC/HC Group A**—Bulk-initiating explosives that have the necessary sensitivity to friction, heat, or percussion (shock) to make them suitable for use as initiating elements in an explosive train. At the Laboratory, for the purpose of procedural controls, a distinction is made between primary initiating explosives and nonprimary initiating explosives. Examples of primary initiating explosives are lead azide, lead styphnate, mercury fulminate, and tetracene. Nonprimary initiating explosives are dry forms of cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), and pentaerythritol tetranitrate (PETN).
- **SC/HC Group B**—Detonators and similar initiating devices that do not contain two or more independent safety features. This group consists of items that contain initiating explosives designed to initiate or continue the functioning of an explosives train. Examples are blasting caps, small arms primers, fuzes, and detonators of all types —excluding exploding bridgewires (EBW) and slapper detonators.

- **SC/HC Group C**—Bulk propellants, propelling charges, and devices containing propellant with or without their own means of initiation. Examples are single-, double-, and triple-base propellants; composite propellants; rocket motors (solid propellant); and ammunition with inert projectiles.
- **SC/HC Group D**—High explosives (HE) and devices containing HE without their own means of initiation. This group includes explosives and ammunition that can be expected to explode or detonate when any given item or component thereof is initiated. It does not include devices containing initiating explosives with independent safety features. Examples are wet HMX, plastic-bonded explosives (explosives formulated with a desensitizing plastic binder), trinitrotoluene, black powder, and EBW and slapper detonators.
- **SC/HC Group E**—Explosives devices without their own means of initiation that contain or have a propelling charge (other than one containing a flammable or hypergolic liquid). Examples are artillery ammunition, rockets, and guided missiles.
- **SC/HC Group F**—Explosives devices with their own means of initiation and with or without propelling charge. Examples are grenades, sounding devices, and similar items with an in-line explosive train in the initiator.
- **SC/HC Group G**—Pyrotechnic materials and devices containing pyrotechnic materials. Examples are devices that when functioning result in illumination, smoke, or an incendiary, lachrymatory, or sound effect.
- **SC/HC Group L**—Explosives or ammunition not included in other SC/HC groups. This group includes explosives or ammunition with characteristics that do not permit storage with other similar or dissimilar materials. Examples are damaged or suspect explosives devices or containers, explosives that have undergone severe testing, fuel/air explosive devices, and water-activated devices. Also included are experimental explosives, explosives of temporary interest, newly synthesized compounds, new mixtures, and salvaged explosives until they have been established to be compatible with the original materials. Types of explosives in this group presenting similar hazards may be stored together.
- **SC/HC Group S**—Explosives, explosives devices, or ammunition presenting no significant hazard. Explosives ammunition, so designated or packed that, when in storage, all hazardous explosives effects are confined and self-contained within the item or package. An incident may destroy all items in a single pack but must not be communicated to other packs. Examples are thermal batteries, cable cutters, explosive actuators, and other ammunition items packaged to meet the criteria of this group.

The procedure for the reclassification of explosives is contained in Appendix 24-B.



### 24.4.3 Storing Explosives

**General Requirements.** The following requirements must be adhered to when storing explosives:

- Store explosives and explosive devices in an approved and locked safe file, magazine, vault, or cubicle.
- Post the area with an appropriate warning sign that prohibits smoking and open flames and states the maximum explosive weight limit permitted by the applicable safety procedure.
- Label each container of stored explosives to identify the contents. Standard labels are available from the Materials Distribution Department.
- Segregate explosives for storage on the basis of compatibility.
- Inspect storage areas and stored explosives at least once a year to ensure continued safe storage.

**Storage Compatibility.** Each explosive material or explosive device shall be assigned to an appropriate hazard/class division and SC/HC group before it is placed in storage. If compatible, different types of explosives may be stored together in the same storage magazine or storage area. The storage compatibility mixing chart in Table 24-2 is used for determining compatibility and group mixing. The possibility of chemical interaction must always be considered when placing any explosive in common storage.

Other exceptions to the storage compatibilities summarized in Table 24-2 include

- Samples of explosives from all groups, up to 2 kg (4.4 lb) total, may be stored in the same cubicle if the cubicle walls are designed to prevent propagation.
- Items from storage compatibility/handling control groups B, C, D, E, F, G, and S may be combined in storage if the net explosive weight does not exceed 454.5 kg (1000 lb) and the items are in approved containers.
- Group L materials can only be stored together if their hazards are similar.

In all other cases, material shall be stored in separate cubicles designated for one of the following categories:

- High explosives.
- Propellants.
- Detonators, actuators, and similar devices.
- Primary and static-sensitive explosives.

**Table 24-2. Storage compatibility mixing chart. Ammunition or explosives in substandard or damaged packaging, in suspect condition, or with characteristics that increase the risk in storage are not compatible with other ammunition or explosives and shall be stored separately.**

Groups	A	B	C	D	E	F	G	L	S
A	Yes <sup>a</sup>	— <sup>b</sup>	No <sup>c</sup>	No	No	No	No	No	No
B	—	Yes	—	—	—	—	—	No	Yes
C	No	—	Yes	Yes	Yes	—	—	No	Yes
D	No	—	Yes	Yes	Yes	—	—	No	Yes
E	No	—	Yes	Yes	Yes	—	—	No	Yes
F	No	—	—	—	—	Yes	—	No	Yes
G	No	—	—	—	—	—	Yes	No	Yes
L	No	No	No	No	No	No	No	Yes	No
S	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

<sup>a</sup>“Yes” means that these groups may be combined in storage. Group L materials can only be stored together if their hazards are similar. Otherwise, mixing is either prohibited or restricted. (Also see note “b”).

<sup>b</sup>Where present, a “—” indicates that when warranted by operational considerations or magazine unavailability, and when safety is not sacrificed, these groups may be combined in storage when approved by a safety procedure.

<sup>c</sup>“No” indicates that combined storage is NOT permitted.

**Storage Review.** A storage review system consisting of a handling review and stability review has been established at LLNL to provide an organized way to eliminate explosives that may have deteriorated with time. The handling review date assigned to each batch of explosive delineates the time interval during which the explosive may be withdrawn for use without additional testing. No work (e.g., heating, mixing, machining, pressing) is to be done on an explosive that has passed its handling review date until the explosive has been retested.

If an explosive is known to degrade in a hazardous fashion during storage or contains stabilizers, a stability review interval shall be assigned defining how often the explosive must be monitored. For energetic materials with inadequate data for determining long-term stability, a stability review interval shall also be assigned. Most LLNL explosives do not require stability review intervals.

The Chemistry and Materials Science Energetic Materials Section (EMS) staff assigns handling and stability review intervals according to the guidelines specified in *Explosives Handling and Stability Review Interval Program at LLNL* (UCRL-ID-120263). Assigned handling and stability review intervals and storage compatibility groups for most explosives stored at the LLNL-Livermore site and Site 300 are available from Hazards Control Explosives Safety personnel.

#### **24.4.4 Laboratory-Scale Operations with Explosives**

Research and development laboratory-type operations and testing facilities constitute a separate category involving guidance, restrictions, and relief from certain safety requirements. The *DOE Explosives Safety Manual*, Chapter II, Section 21, and this section contain requirements for laboratory-scale operations. At LLNL, experiments and work areas involving no more than 500 grams of explosives are designated as laboratory-scale operations. Manufacturing or production activities involving small quantities of explosives are not included in this definition. The design of explosives laboratories for personnel protection is described in Chapter 6, Section 6.13, of the *Health & Safety Manual*.

Each operation at facilities designated for blast and fragment confinement shall be reviewed to ensure that the explosives limits are within the laboratory or test area capability. Explosives limits and safe separation distances shall be adjusted as the capability to confine fragment and blast decreases.

Each proposed program for the laboratory or test facility shall be reviewed to determine all potential hazards. Considerations shall include

- Structural limitations of the facility.
- Remote control viewing and operating equipment, if required.
- Special safety precautions for personnel elsewhere in the building.
- Safe separation distances.
- Required deviations from other sections of this chapter.
- FSPs or OSPs, which shall define the following as a minimum:
  - Protective clothing.
  - Warning signals.
  - Fire and other emergency procedures.
  - Special testing of equipment needed before operations (such as stray voltage and calibration checks).
  - Removal of all explosives not needed for the operation.
  - Arrangements for overnight storage of necessary explosives.
  - Inspection and cleanup procedures after a test or detonation.

Laboratories shall use no more explosives than absolutely required for a given operation. Particularly hazardous laboratory operations involving new (or relatively unknown) explosives shall be done by remote control. Operational shields shall be used in these operations and in new or untested applications of explosives.

#### **24.4.5 Operations and Materials that Require Special Controls**

**Heating Explosives.** It is common practice to heat an explosive for the purpose of drying, pressing, curing, or thermal testing. However, improper application of heat can cause an explosion. If the amount of explosive involved is large, this could be catastrophic. Whether an explosion will occur depends on many factors, the most important of which are the chemical properties of the explosive, mass of

the explosive, and physical condition (i.e., confined, unconfined, or geometry) of the system.

The critical temperature of an explosive is the lowest temperature at which the explosive in a given configuration self-heats to explosion. Although this temperature generally is to be avoided, it certainly is not the only danger during the heating process (e.g., thermal degradation with gas pressure buildup, burning). Therefore, before heating an explosive, know the maximum safe temperature that can be used for that explosive configuration.

When heating explosives, use the mildest set of conditions that will accomplish the task safely and efficiently. The *DOE Explosives Safety Manual*, Chapter II, Sections 12 and 13, describes the hazards and precautions that must be observed when heating explosives. Any operation or experiment that involves the heating or drying of an explosive must be authorized by a peer-reviewed safety procedure or "Peer Review For Explosives" procedure (available from the Energetic Materials Section staff or Hazards Control Explosives Safety representatives).

**Machining Explosives.** Explosives machining is a class of forming operations that involves mechanical cutting of the explosive material, often in conjunction with harder inert materials. These forming operations include turning, drilling holes, coring, and sawing. All explosives are to be machined remotely unless the explosive is listed below as approved for contact machining. Machining explosives without liquid coolant, including the ones listed below, or in combination with metal must also be done remotely. During remote machining, the operator either must be protected by a suitable operational shield or be in a control room that provides adequate protection from blast and fragments.

The explosives listed below are approved for contact machining. Appendix 24-B contains the testing procedures required before an explosive can be designated as Contact Machinable.

- Amatol.
- Baratol.
- Boracitol.
- Explosive D.
- Octol (to 75% HMX).
- Pentolite (to 50% PETN).
- RDX/TNT compositions with no more than 75% RDX. These include Composition B, Composition B-3, and 75/25 cyclotol.
- TATB and TATB compositions with an inert plastic binder.
- TNT.

NOTE: Any explosive material that is not approved for contact machining must be machined remotely.

**Operations with Large Explosive Charges.** As the weight of an explosive or explosives device increases, the accident risk from mishandling also increases because of the greater likelihood of ignition and the increased severity of the consequences. When any LLNL-directed operation involves a large Hazard Class/Division 1.1 explosive charge, the additional controls and reviews listed in these sections are required and must be included in the authorizing safety procedure.

Explosive materials that are fully classified and approved by the DOE Explosives Safety Committee as insensitive high explosives (IHEs) or IHE subassemblies, as specified in Chapter IX of the *DOE Explosives Safety Manual*, are exempt from the requirements of this section (see details on the following page).

A large explosive charge either may be

- A bare Hazard Class/Division 1.1 explosive billet or part that weighs 25 kg (55 lb) or more.
- An explosive assembly, including fixturing or other attached hardware, that contains an exposed Hazard Class/Division 1.1 explosive and weighs 25 kg (55 lb) or more. (An exposed explosive is not completely enclosed by a physical covering that would provide significant protection in the event of a handling accident. Pin dome hydro assemblies consisting of the shot stand and case are examples of assemblies that are not vulnerable to impact on bare internal explosive materials and thus are exempt from this definition.)

Existing safety procedures for handling explosives that do not provide the safety elements listed below shall be supplemented by an additional assembly procedure with a Peer Review For Explosives or a peer-reviewed OSP. As a minimum, these detailed written procedures must address the following additional operational restrictions and precautions:

- Minimize the possibility of dropping the explosive during handling.
- Prevent dangerous impact in the event of a handling accident.
- Limit any adverse effects of the sensitivity and thermal stability properties of the explosive.
- Eliminate hazardous chemical reactions between the explosive and any materials it may contact.

The supplemental procedure must comprehensively consider all safety aspects of fabrication, transportation, and handling during every operation with the material. Before authorization can be given, the supplemental procedure must include a review by a member of the LLNL Large Charge Committee, Hazards Control Explosives Safety, and Facility Management for each facility involved.

**Low-Energy Initiators.** Low-energy initiators (LEIs) are electro-explosive devices (EEDs) containing energetic materials that are initiated by 0.1 J or less. LEIs are more electrically sensitive than either EBW or slapper detonators, and

their use requires greater control to maintain a low level of risk. LLNL policy prohibits the use of LEIs whenever high-energy EEDs can be used for the same purpose. If an LEI must be used in a specific application, the experimenter must supply information concerning the safety of the LEI to the Hazards Control Explosives Safety representative responsible for the area (including the Nevada Test Site) who will forward this information to the LEI Committee for review.

For additional details concerning the control of LEIs, refer to Supplement 24.09 of the *Health & Safety Manual*.

**Insensitive High Explosives.** Some mass-detonating explosives are so insensitive that the probability of accidental initiation or transition from burning to detonation is negligible. This insensitivity to detonation permits the explosive to be handled and worked with somewhat less restrictive controls than are normal for a mass-detonating explosive. A safety procedure authorizing work with an IHE having less restrictive controls will describe the IHE-specific controls approved for its use. To be categorized as an IHE, an explosive must pass a series of qualification tests described in the *DOE Explosives Safety Manual* and be approved by the DOE Explosives Safety Committee.

**Mock High Explosive.** During some tests, it is often convenient to use a material that cannot be detonated but which possesses a compositional or physical property of an explosive. A mock high explosive (Mock HE) is a nondetonable material used to simulate one or more properties of a high explosive. Names and formulations of some Mock HEs are listed in the *LLNL Explosives Handbook: Properties of Chemical Explosives and Explosive Simulants* (UCRL-52997). Hazards Control Explosives Safety personnel can provide additional information.

Mock HE is a controlled material, and guidelines for its proper use are contained in Chapter 8.

Within the DOE Complex, Mock HE is colored pink (or mottled white and pink) to indicate that it is an explosive simulant and not an explosive formulation. Conversely, explosive formulations that are pink in color are not to be used at LLNL unless there is a safety procedure specifying the measures to be taken to avoid confusing the pink explosive with Mock HE. As an additional aid to identification, Mock HE parts or containers containing Mock HE shall be labeled "MOCK HE." The assigned name and lot information code shall also be included to facilitate composition verification.

Mock HE is not necessarily inert and should not be labeled as such. It may be toxic or combustible, or it may possess other hazardous properties. All that can be said about Mock HE is that it cannot detonate. Wear gloves when handling Mock HE powder. Avoid breathing its dust or the vapors from heated material by using a respirator with a particulate cartridge or an adequate dust-collection system. Dispose of unclassified Mock HE parts through Hazardous Waste Management, and give classified Mock HE parts to the Materials Management Section for disposal.

**Adhesives, Fillers, and Coatings Used with Explosives.** Adhesives, fillers, and coatings that come into direct contact with explosives must be carefully selected to ensure they do not degrade an explosive's performance, and that a finished assembly will meet the design criteria. In addition, these materials must not react with the explosive in any way to produce a toxic or hazardous reaction. Properties, formulations, compatibilities, and handling precautions for the various adhesives, fillers, and coatings that may be used with explosives are described in Supplement 24.11 of the *Health & Safety Manual*.

#### **24.4.6 Procurement of Explosives**

All explosives are normally ordered through Procurement. However, if other arrangements are made, a memo shall be sent by the requester to the Site 300 Controlled Materials Group (CMG, L-818) and Hazards Control Explosives Safety (L-871) stating what explosive material is coming and the supplier's name. Contact the CMG at Site 300 (ext. 3-5334) for the correct shipping address and delivery instructions. Information copies of routine purchasing requisitions must be sent by Procurement to CMG and Hazards Control Explosives Safety well before the material is shipped to Site 300 to ensure the material is acceptable and that there is available storage space.

All requisitions and any other documents needed for procuring explosives must indicate the name of the explosive material and the fact that it is an explosive. When ordering an explosive not previously used at LLNL, the requester must obtain all necessary information about the explosive's composition, safe-handling procedures, storage shelf life, storage stability information (if applicable), shipping information, and a Material Safety Data Sheet from the manufacturer or supplier. The requester also must obtain a handling review date and stability review date (if applicable) from the Energetic Materials Section (EMS). The "Explosives Handling Review, Stability Review, and Shipping Data" form (Appendix 24-C) is used to submit the safety data. This form is available from the EMS staff or Hazards Control Explosives Safety personnel.

Requests made to an outside agency for fabricating or handling a large explosive charge must first be reviewed by the EMS Leader (or his/her designee), who will review properties of the explosive and how they may affect the safety of the operation. The EMS staff may also suggest more suitable explosives that will still meet design needs.

#### **24.4.7 Shipping, Transferring, and Transporting Explosives**

The Site 300 Controlled Materials Group (CMG) of the Materials Management Section (of the Mechanical Engineering Department) is responsible for packaging and labeling explosives shipments leaving Site 300 in a manner that complies with DOT, DOE, and LLNL standards. The Operations Group of the Materials Management Section is responsible for packaging and labeling explosives shipments leaving the LLNL-Livermore site in compliance with the same standards. To ensure that these standards are observed, all explosives shipments to or from offsite locations must be delivered to Building 818 at Site 300 for

processing. In special cases, the CMG may determine that the destination or weight of the explosives shipment is such that processing can be better handled at another facility. Controls for shipping, transferring, and transporting explosives are described in Supplement 24.05 of the *Health & Safety Manual*.

Only authorized personnel in approved vehicles are permitted to transport explosives onsite and offsite. The Materials Management Section or the Material Transportation Group at Site 300 can provide additional information.

#### **24.4.8 Use of Electrical Equipment**

**NEC Standards.** Because explosives may be sensitive to heat, arcs, or sparks, electrical equipment and wiring must be carefully designed and installed to limit the possibility that electrical equipment will become a source of ignition during either normal or abnormal operating conditions. The National Electric Code (NEC) and the *DOE Explosives Safety Manual* specify minimum requirements for facilities containing explosives. All fixed electrical equipment and wiring for explosives work areas containing more than 500 grams (1.1 lb) of explosives shall conform to the NEC standards for hazardous locations, Class II or Class I and II (dual rated).

**Portable Equipment Requirements.** Portable equipment (research equipment) shall also conform to the appropriate NEC classification when installed within the explosives work areas. In some cases, equipment not otherwise acceptable for use in a hazardous location may be used if it is surrounded by an adequately purged and pressurized enclosure (see National Fire Code Standard NFPA-496). In other cases, equipment that is neither designed for hazardous locations nor capable of being purged may be used in the explosives work area when its presence does not increase risk and its use is authorized by an Electrical Authorization tag (LL-3590) affixed to each piece of equipment. These tags are authorized by the facility or area supervisor and Hazards Control Explosives Safety personnel.

Some electrical equipment or operations are unacceptable for explosives work areas. In these cases, the explosives hazard must be removed before the work is started or the equipment is installed. The Hazardous Work Permit (LL-1986) indicates concurrence of the Facility Supervisor and Hazards Control that the explosives hazard has been removed and the work in question can proceed.

**Test Meters for Explosives Systems.** Many explosives systems used by LLNL are detonated by applying electrical energy to an initiation circuit within the system. It often becomes necessary to test these and other circuits for continuity and resistance with an electrical instrument such as an ohmmeter. Some test meters, however, can supply a large enough current to the meter probes (through either normal operation or a fault condition) to cause the system being checked to detonate. To prevent this from happening, test meters used with explosive systems must be rigorously controlled and approved by the High Explosives Instrument



Committee (HEIC). In addition, all test meter users must be familiar with LLNL's control system, as described in Supplement 24.15 of the *Health & Safety Manual*.

#### 24.4.9 Explosives Waste Management

At LLNL, explosives waste and explosives-contaminated waste have been segregated into specified waste forms for the purposes of handling, storage, and disposal. The description of each explosive waste form and examples of each are given below.

- **Form 1: Explosives Requiring Detonation**—Waste explosives in such a configuration that LLNL requires them to be treated by open detonation. This waste form includes cased explosives or other explosives that may detonate during thermal treatment operations.
- **Form 2: Waste Explosives**—Consists of two subwaste forms:
  - *Form 2A: Explosive Materials and Formulations*—Waste explosives powders, pastes, liquids, and pieces derived from either pure materials or formulated products. Waste explosives can also include explosives parts that have been cast, pressed, or machined to shape. Waste explosives are generated by cleanup from formulation, processing, and testing operations or by removal from inventory of stored materials or items.
  - *Form 2B: Small Explosive Assemblies or Devices*—Waste explosives that are cased in a small assembly or device, such as a detonator.
- **Form 3: Wastes from Explosives Collection Systems**—Consists of two subwaste forms:
  - *Form 3A: Clarifier Waste*—Explosives sludge collected from explosives-processing wastewater clarifier systems.
  - *Form 3B: Weir System Waste*—Explosives-contaminated sludge mixed with other debris. This waste is collected from the explosives-processing wastewater weir system settlement basins.
- **Form 4: Reactive Debris**—Debris contaminated with energetic materials. This waste consists primarily of contaminated paper, rags, and other clean-up materials from explosives operations. The contamination is distributed in such a manner that the waste is judged to retain explosives properties.
- **Form 5: Non-Reactive Debris**—Debris slightly contaminated with energetic materials and similar to Form 4, with respect to the non-reactive component. The small quantities of contamination are so well dispersed that the waste does NOT retain explosive properties. The total quantity of contamination in the debris is controlled to trace amounts (approximately 1% or less by weight).

Explosives waste and explosives-contaminated waste are to be managed in accordance with the controlling safety procedure for the explosives operation. Explosives wastes must not be generated where there is no acceptable method for disposal or transport on public highways. The Hazardous Waste

Management Division will coordinate the proper storage, transfer, and treatment (if applicable) of these materials generated at LLNL-Livermore or Site 300. Materials generated at Site 300, as well as those wastes transported from LLNL-Livermore to Site 300 for treatment, shall be managed in accordance with the procedures controlling Site 300 explosives waste treatment facilities.

#### **24.4.10 Hazardous Work Permits**

A Hazardous Work Permit (Form LL-1968) is required for new construction, modification, maintenance, or repair work to be performed in any area designated as an explosives storage or handling area at LLNL-Livermore or Site 300 if any of the following conditions apply:

- Open-flame cutting or soldering.
- Welding (gas or electric) or grinding.
- Open fires for any purpose. (Controlled burning of grass requires special management review and approval and is exempt from this Hazardous Work Permit requirement.)
- Use of heat-producing ( $>228^{\circ}\text{F}/109^{\circ}\text{C}$ ), spark-producing, or impact tools.
- Use of electric power tools or powder-actuated tools (e.g., stud gun).
- Maintenance or repair work performed by offsite contract personnel.

The safety responsibility during construction, maintenance, and repairs is shared by the worker, his/her supervisor, and the Facility Supervisor. Hazards Control Explosives Safety personnel shall review and approve the Hazardous Work Permit and inspect locations to ensure all explosives hazards have been removed and that appropriate safety precautions have been taken. Hazards Control Explosives Safety personnel can provide additional guidance for using and issuing these permits.

#### **24.4.11 Emergencies**

**Fire.** The most serious emergency in an explosives work area is fire. Since most explosives are flammable and may detonate when exposed to excessive heat, take extreme care to eliminate sources of ignition from explosives work areas.

In the event of a fire, immediately evacuate the work area unless the fire can definitely be extinguished before it gets near the explosive. Do not attempt to extinguish a fire directly involving an explosive. After the occupants evacuate to a safe area, dial the emergency dispatcher (LLNL-Livermore and Site 300, ext. 911) and give the necessary information. Take any additional actions specified in the safety procedure controlling the area.

Supplement 24.30 of the *Health & Safety Manual* describes how emergency personnel and facility personnel respond to a fire in an explosives area. It also contains information on hazard classifications, placarding facilities with fire division symbols, and setback distances.

**Reactive or Unstable Chemicals.** On occasion, compounds in chemical supply rooms and other laboratory work areas have been found to contain constituents that have become reactive or unstable as a result of decomposition, dehydration, or peroxidation or are classified as explosives and must be handled accordingly. Chemicals that appear to have developed into an unstable state should not be handled or removed until appropriate guidance has been given by the ES&H team industrial hygienist. Chapter 21 of *Health & Safety Manual*, “Chemicals,” provides additional information on peroxidizable chemicals. The ES&H team explosives safety engineer can provide information regarding the classification of questionable chemicals. (The explosives safety engineer also maintains a list of chemicals that have been previously reviewed and determined to be explosives.) These materials must be stored and handled as explosives.

**Lightning.** Because of the hazards introduced into explosives operations by lightning, certain operations must be stopped during the approach of lightning storms. A lightning warning system operates at the LLNL-Livermore site (Bldg. 191) and at Site 300 (Bldg. 848 Weather Station with a readout to Bldg. 871).

The lightning warning system procedure for Building 191 is described in the FSP for that building. The lightning warning system procedure for Site 300 explosives facilities is described in the site-specific FSPs. Explosives operations that would be curtailed during lightning conditions must be included in the safety procedure controlling that operation.

#### **24.4.12 Process Safety Management**

The OSHA requirements for process safety management in 29 CFR 1910.119 apply to some explosive operations, depending on the quantity present, and to any process that involves any quantity of an explosive or pyrotechnic material in a manufacturing process. Contact the ES&H team for implementation guidance.

## **24.5 Responsibilities**

This section describes the responsibilities of individuals involved in the LLNL Explosives Safety Program.

### **24.5.1 Managers**

Managers must ensure that all explosives operations performed by personnel for whom they are responsible comply with the requirements in this chapter and those in the *DOE Explosives Safety Manual* (DOE M 440.1-1).

The organization responsible for the work must write, review, approve, and distribute safety procedures that incorporate these requirements.

Managers are responsible for assigning trained and qualified personnel to perform the functions described in this chapter, providing on-the-job training (OJT), and ensuring that personnel reporting to them possess the knowledge and skills to perform the work safely. They are also responsible for arranging and

obtaining medical clearances for explosives handlers before allowing them to routinely handle bare explosives.

Department Heads of custodians of explosives materials shall review the annual report of the Site 300 CMG inventory of explosives stored in CMG facilities and determine programmatic justification for continued storage (or arrange for alternate disposition).

#### **24.5.2 Qualified Explosives Handlers**

Qualified explosives handlers are responsible for conducting their work in accordance with the requirements in this chapter and applicable procedures developed within their directorate, and within the limitations established as described on each employee's Training Qualification Record.

#### **24.5.3 ES&H Teams**

The ES&H team is responsible for notifying the emergency dispatcher at Fire Station I for LLNL-Livermore facilities and Station II for Site 300 facilities whenever any safety procedure for explosives operations changes the status of an Emergency Response Plan.

#### **24.5.4 Hazards Control Explosives Safety Personnel**

Hazards Control Explosives Safety personnel, working through the ES&H teams, are responsible for

- Interpreting applicable codes, standards, and regulations.
- Serving as Laboratory representatives on the DOE Explosives Safety Committee. (Individuals are appointed by Hazards Control Department Head.)
- Coordinating the formulation of LLNL-Livermore explosives safety policy and standards for approval by management.
- Providing hazards analysis and safety guidance to LLNL staff members who work with solid or liquid explosives.
- Preparing and conducting explosives safety training and maintaining qualification records of explosives handlers.
- Auditing the operations, facilities, and equipment that are part of the LLNL Explosives Program and making appropriate reports to management.
- Analyzing management errors, accidents, and incidents and making recommendations to prevent recurrences.
- Compiling and distributing explosives safety information to personnel working with explosives and other personnel requiring this information.
- Providing planning for (and information during) emergency responses involving explosives.

#### **24.5.5 Procurement Department**

When explosive materials or explosives devices are ordered through the Procurement Department, the respective procurement specialist shall follow all applicable Procurement Procedures and Supplemental Instructions when placing purchase requisitions for explosives and mock explosives. The responsible procurement specialist ensures that these materials and items are designated for delivery to facilities approved for their storage and use.

#### **24.5.6 Materials Management Section**

The Site 300 Controlled Materials Group (CMG) of the Materials Management Section is responsible for packaging and labeling explosives shipments leaving Site 300 in a manner that complies with DOT, DOE, and LLNL standards. The Site 300 CMG is also responsible for distributing an annual inventory report of explosives stored under its control to respective Department Heads, who must justify continued long-term explosives storage and update consignor lists.

The Operations Group of the Materials Management Section is responsible for packaging and labeling explosives shipments leaving the LLNL-Livermore site in compliance with the same standards and for disposing of classified Mock HE parts.

#### **24.5.7 C&MS Energetic Materials Section**

The Energetic Materials Section (EMS) Leader is responsible for maintaining a competent staff capable of performing peer reviews of explosives operations. The EMS staff members are responsible for reviewing new explosives materials for assignment to the appropriate hazard classification, and for assigning handling and stability review intervals in accordance with the guidelines in the *Explosives Handling and Stability Review Interval Program at LLNL* (UCRL-ID-120263). The EMS Leader oversees the actions of the LLNL Explosives Safety Committee and appoints the chairperson of this committee.

#### **24.5.8 LLNL Explosives Safety Committee**

One purpose of the Explosives Safety Committee is to provide an approving authority for each phase of an explosives development program. As such, this committee satisfies the requirement for the existence of an Explosives Development Committee, as set forth by the *DOE Explosives Safety Manual*. When requested, this committee also reviews standard operating procedures for experiments involving explosives and new explosives operations and equipment, and advises the EMS leader and the respective Facility Managers on policies and practices affecting safety. This committee also reviews and approves requests for explosive reclassification. The committee includes various review groups, subcommittees, such as Peer Review, and the Low Energy Initiator Committee.

#### **24.5.9 Hazardous Waste Management Division**

The Hazardous Waste Management Division oversees the collection, treatment (if applicable), and disposal of regulated wastes; develops and implements hazardous waste-handling procedures, operations, and reporting systems; collects, treats, and stores wastes before shipping to (as applicable) offsite recyclers and treatment and

disposal facilities; tracks and documents the movement of hazardous waste from Waste Accumulation Areas to final treatment, storage and/or disposal areas; responds to environmental emergencies; and participates in spill cleanup.

#### **24.5.10 Health Services Department**

The Health Services Department is responsible for establishing a Medical Surveillance Program and monitoring LLNL employees who handle bare explosive materials. The Health Services Department can answer questions employees may have regarding potential health effects of explosives handling and the need for medical surveillance.

#### **24.5.11 Mechanical Engineering Department**

The Mechanical Engineering Department is responsible for ensuring that its designs, fabrications, assemblies, mockups, and other equipment and materials associated with the LLNL Explosives Program are properly reviewed and are in accordance with the requirements in this chapter and applicable procedures developed within its directorate.

### **24.6 Training and Qualification of Explosives Users**

Before employees are authorized to handle explosives, they must understand the hazards and safe practices associated with this work. The training that employees receive is determined by their current knowledge of explosives and the requirements of the job. Although Hazards Control conducts formal training classes in explosives safety, supervisors bear primary responsibility for providing OJT and ensuring that their personnel possess the knowledge and skills needed to perform the work safely.

#### **24.6.1 Initial Qualification**

Documentation and approval of the training and qualification of explosives users is provided by either using a Training Qualification Record (Form RL-2999-9 or equivalent) or specifying the person's name and qualifications in the safety procedure covering the operation. Line management shall develop OJT requirements for assignments and document the completion of all safety critical tasks in the Training Qualification Record or in a safety procedure.

#### **24.6.2 Medical Clearance and Surveillance**

Supervisors must arrange for and obtain medical clearances for explosives handlers before allowing them to routinely handle bare explosives. Liver function tests are required annually for explosives handlers. Medical surveillance examinations are required on an age-adjusted basis (every two years under age 45; annually after age 45).

#### **24.6.3 Annual Review**

The supervisor must annually review each explosives handler's qualifications and work assignment to ensure that the person is still capable of performing the operations indicated on the Training Qualification Record. In addition, the review will include a discussion of recent changes in pertinent procedures and

other safety matters of concern to the supervisor or the employee. This review shall be recorded on an Explosives User's Qualification Review form (or a similar form), which can be obtained from Hazards Control Explosives Safety personnel. A copy of this form shall be retained with the employee's Training Qualification Record.

#### **24.6.4 Suspension of Qualification**

Do not permit any employee to continue working with explosives if he/she is unable to perform the job safely because of physical injury, disease, mental disturbances, a period of inactivity in work with explosives, and so forth. When the employee is able to return to work with explosives, the supervisor will determine whether that person is still qualified. If not, the supervisor must initiate a new Training Qualification Record for that employee.

#### **24.6.5 Age Restrictions**

No person under 18 years of age shall be permitted to use or handle explosives or engage in any activity relating to blasting operations. No person between 18 and 21 years of age shall be permitted in any explosives magazine or be permitted to use or handle explosives, except under the direct supervision of a qualified explosives user. No person under 21 years of age shall transport explosives.

### **24.7 LLNL Contacts**

Contact the following, as appropriate, for further guidance or additional information:

- ES&H team (the telephone number varies by area).
- Explosives Safety Technical Leader, ext. 2-5128.
- Site 300 Controlled Materials Group, ext. 3-5255.
- Chemistry & Materials Science Energetic Materials Section Leader, ext. 3-7455.
- Hazardous Waste Management Division, ext. 2-1996.
- Health Services Department, ext. 2-7459.

### **24.8 References and Supporting Standards**

*DOE Explosives Safety Manual* (DOE M 440.1-1).

*Explosives Handling and Stability Review Interval Program at LLNL* (UCRL-ID-120263).

*LLNL Explosives Handbook: Properties of Chemical Explosives and Explosive Simulants* (UCRL-52997).

NFPA 70, *National Electrical Code* (latest edition).

NFPA-495, *Explosives Materials Code* (latest edition).

## Appendix 24-A

### Explosives by Storage Compatibility/Handling Control Category

#### 24A.1 Explosives

LLNL has converted to the UNO hazard classification system for classifying explosive materials and explosive components. Each storage compatibility/handling control (SC/HC) group is described in Section 24.4.2 of this chapter.

For the purpose of cross-referencing and converting explosive materials and explosive components identified under the old system to the new SC/HC system, the previously used LLNL explosive types are defined in Table 24A-1. Contact Hazards Control Explosives Safety personnel to resolve questions concerning classification conversion from the previous handling classification type to the new UNO hazard classification system.

The handling classification type in use prior to May 1, 1994 is noted within square brackets [] for the explosives listed by UNO SC/HC group in Section 24A.2. Explosives without brackets were not specifically listed in earlier versions of this appendix.

**Table 24A-1. Definition of previously published LLNL handling classification types.**

Explosive type	Definition
Type O	A material or device that need not be handled, stored, or labeled as an explosive unless it is close to other explosive that could initiate it.
Type A	A high-explosive material that has met the safe criteria for sensitivity and stability and has sufficient handling history to reveal any characteristics that affect its safe use.
Type B	A propellant or perchlorate explosive material that meets the same criteria as Type A.
Type C	An electroexplosive device that requires a rapid discharge of high electrical energy for initiation, contains no LLNL Type E explosive, and is not sensitive to radiofrequency (rf) energy or electrostatic discharges from the human body.
Type D	An electroexplosive device that requires only small amounts of electrical energy for initiation.
Type E	An initiating explosive, a friction- or spark-sensitive material, or a device not meeting the criteria for Type O, C, or D explosives.
Type X	Any other explosive not described above.



## 24A.2 Explosives Listed by UNO SC/HC Group

---

### Group A—Initiating explosives (\* indicates primary initiating explosives)

CL-20 (Hexanitrohexaazaisowurtzitane) (dry)  
CP (5-Cyanotetrazolpentaamine Cobalt III perchlorate)  
HMX (Cyclotetramethylene tetranitramine (dry) [X]  
\*Lead azide [E]  
\*Lead styphnate [E]  
\*Mercury fulminate [E]  
\*Nitrocellulose (dry) [E]  
PETN (Pentaerythritol tetranitrate) (dry) [E]  
RDX (Cyclotrimethylene trinitramine) (dry) [E]  
\*TATNB (Triazidotrinitrobenzene) [E]  
\*Tetracene [E]

---

### Group B—Detonators and similar initiating devices

Blasting caps [E]  
Detonators (excluding EBW and slapper)  
Explosive bolts [D]  
Fragmenting actuators [D]  
Ignitors [D]  
Low-energy initiators (LEIs) [D]  
MDF (mild detonating fuze) detonator assemblies  
Pressure cartridges [D]  
Primers [O]  
Squibs [D]

---

### Group C—Bulk propellant, propellant charges, and devices containing propellants with or without their own means of initiation

Smokeless powder [B]  
Pistol and rifle powder [B]  
Rocket-motor solid propellants

---

**Group D—HE and devices containing explosives without their own means of initiation (\* indicates that classification may change depending on nitrogen and moisture content. Contact Hazards Control Explosives Safety for additional guidance.)**

Ammonium picrate  
Baratol [A]  
Black Powder [E]  
Boracitol  
Chemical lenses  
CL-20 (Hexanitrohexaazaisowurtzitane) (wet)  
Compositions A, B, and C (all types) [A]  
Cyclotols ( $\leq 85\%$  RDX) [A]  
DATB (Diaminotrinitrobenzene) [A]  
Detasheet [A]  
Detonating cord (primacord or mild detonating fuze) [A]  
bis-Dinitropropyl adipate  
bis-Dinitropropyl glutarate  
bis-Dinitropropyl maleate  
Dinitropropane  
Dinitropropanol  
Dinitropropyl acrylate monomer (DNPA)  
Dinitropropyl acrylate polymer (PDNPA) [O]  
EBW and slapper detonators [C]  
Elastomeric plastic bonded explosives  
Explosive D  
GAP (Glyceryl azide polymer)  
HMX (Cyclotetramethylene tetranitramine) (wet) [X]  
HMX/wax (formulated with at least 1% wax)  
HNS (Hexanitrostilbene (wet or dry) [X]  
Linear-shaped charge [A]  
Methyl dinitropentanoate  
Mild detonating fuse (MDF)  
NG/TA (Nitroglycerine-triacetone)  
\*Nitrocellulose (wet) [X]  
Nitroguanidine (NQ) [A]  
Octol ( $\leq 75\%$  HMX) [A]  
Pentolite [A]  
PETN (Pentaerythritol tetranitrate) (wet) [X]  
PETN/extrudable binder [A]  
PGN (Polyglycidyl nitrate)

**Group D—(Continued)**

Plane wave lenses (composed of SC/HC Group D explosives) [A]  
Plastic-bonded explosive, PBX (a SC/HC Group D formulated with a desensitizing binder) [A]  
Potassium picrate  
Primacord [A]  
RDX (Cyclotrimethylene trinitramine) (wet) [X]  
Shaped charges (composed of SC/HC Group D explosives) [A]  
TATB (Triamino trinitrobenzene) [A]  
TATB/DATB mixtures [A]  
TEGDN (Triethylene glycol dinitrate)  
Tetryl [A]  
TMETN (Trimethylolethane trinitrate)  
TNAZ (Trinitoazetidine)  
TNT (Trinitrotoluene) [A]

---

**Group E—Explosives devices without their own means of initiation and with propelling charge**

Artillery ammunition  
Rockets (e.g., M66 LAW)

---

**Group F—Explosives devices with detonators and detonating trains assembled to the devices and with propelling charge**

Grenades  
Sounding devices

---

**Group G—Pyrotechnic material and devices that produce an incendiary, illumination, lachrymatory, smoke, or sound effect**

Smoke pots (when in lots of 50 or more) [O]  
Flares  
Incendiary ammunition [O]

---

**Group L—Explosives or other ammunition not included in other SC/HC groups**

Damaged or suspect explosives devices or containers  
Explosives that have undergone severe testing  
Experimental explosives, explosives of temporary interest, newly synthesized compounds, new mixtures, and some salvaged explosives [X]

---

**Group S—Explosives, explosives devices, or ammunition presenting no significant hazard**

Propellant cartridge-actuated devices (which yield a nonfragmenting, nonflame-producing controlled reaction). Examples include cable cutters, cartridge-actuated valves, and linear actuators (e.g., dimple, piston, bellows motors) [O]

Safety fuze

Small arms ammunition [O]

Smoke pots or similar devices (when in lots of less than 50) [O]

Thermal batteries

---

**24A.3 Other Energetic Materials**

The energetic materials listed below are materials and systems that do not need to be stored or labeled as explosives, unless they are near other explosives that could initiate them. When near explosives, these materials become SC/HC Group D unless otherwise indicated.

BDNPA

BDNPA/F, 50/50 wt%

Explosive, SC/HC Group A (nonprimary initiating explosives only) and SC/HC Groups C and D,  $\leq 10$  mg

Explosive, SC/HC Group A primary initiating explosives,  $\leq 1$  mg

FEFO/SOL (35 wt% or less FEFO in ethyl acetate or 25 wt% or less FEFO in methylene chloride) [O]

FM1 solution

Group D explosives in inert solvents (explosives concentration not exceeding 25 wt%) [O]. The guidance has been temporarily superceded. Solutions  $>10$  mg HMX, regardless of the weight percent, must be handled in authorized explosives areas until further notice. There have been two recent LLNL occurrences involving 25 weight percent HMX-based materials dissolved in dimethyl sulfoxide (DMSO). In one case a single crystal, as large as 25 mm (1 in.), unexpectedly grew from a freshly prepared solution in just two days. Contact your area ES&H Team Explosive Safety representative for further information.

Nitrates (Treat as SC/HC Group C when with other explosives.)

Nitromethane

Nitropropane

Perchlorates (Treat as SC/HC Group C when with other explosives [X].)

Picric acid (containing at least 10 wt% water and in less than 11-kg lots [O])

Small arms ammunition classified for shipment as ORM-D (Other Regulated Material Class D) rather than Hazard Class/Division 1.4S explosives.

Normally consists of ammunition not exceeding 50 caliber for handguns and rifles and 8 gauge for shotguns.



## **Appendix 24-B**

### **Reclassification of Explosives**

#### **24B.1 Introduction**

Initially, newly synthesized compounds, new mixtures and explosive material, and new explosives devices are automatically assigned to the Hazard Class/Division 1.1 and SC/HC Group L classification.<sup>1</sup> Before this classification can be changed, information from various tests performed on the explosive or other pertinent safety data must be reviewed and approved by the LLNL Explosives Safety Committee (explosive materials) or Hazards Control Explosives Safety personnel (explosives devices).

#### **24B.2 Reclassification of Explosive Materials**

New explosive materials are all initially classified as SC/HC Group L with a machining classification of Remote. To initiate the reclassification process, the experimenter or requester must submit a completed Explosives Handling Review, Stability Review, and Shipping Data form (Appendix 24-C; also available from the Energetic Materials Section (EMS) staff) to the EMS Leader. After EMS peer review and concurrence with this report, Hazards Control Explosives Safety will arrange to publish the new classification in the appropriate listings, manuals, and procedures.

##### **24-B.2.1 Required Tests**

The following tests are required for explosives that have been reclassified:

- Impact sensitivity.
- Spark sensitivity.
- Differential thermal analysis (DTA) or differential scanning calorimetry (DSC).

##### **24B.2.2 Additional Recommended Tests**

The following additional tests may be recommended at the discretion of the EMS Leader or Hazards Control Explosives Safety:

- Friction sensitivity—small-scale test.
- Shock sensitivity—gap test.
- LLNL chemical reactivity test (CRT).
- One-dimensional time-to-explosion (ODTX).

---

<sup>1</sup>Unless there is sufficient information on sensitivity, stability, and handling history for assignment to another SC/HC Group.

### **24B.3 Reclassification of Explosive Devices**

Explosives devices are manufactured components containing explosives; all are initially classified as SC/HC Group L. Hazards Control Explosives Safety will review available information and reclassify those devices that clearly meet the criteria for other SC/HC Groups. Explosive detonators and similar initiating devices with questionable characteristics will be referred to the LEI Committee for resolution. For additional information on the functions of the LEI Committee, see Supplement 24.09 of the *Health & Safety Manual*.

### **24B.4 Reclassification to Contact Machining**

Explosives are all initially classified as Remote Machinable. To reclassify an explosive as Contact Machinable, a Peer Review For Explosives Procedure describing and initiating a machining overttest program and an attached report detailing the results of the other required tests are prepared. After satisfactory completion of the machining overttests, and with the concurrence of those involved, a request is forwarded by Hazards Control Explosives Safety to the chairperson of the DOE Explosives Safety Committee to add the explosive to the list of contact-machinable explosives contained in the *DOE Explosives Safety Manual*. After approval by the DOE Explosives Safety Committee, Hazards Control Explosives Safety will arrange for dissemination of the information.

#### **24B.4.1 Required Tests**

The following tests are required to reclassify explosives for contact machining:

- All of the tests required to reclassify explosives to SC/HC Group D.
- Sliding impact sensitivity—LLNL/Pantex Skid Test.
- Machining overttest program, which involves sawing, machining, and drilling without coolant and is designed to exceed the speed and feed parameters normally used.



## **Appendix 24-C**

### **Explosives Handling Review, Stability Review, and Shipping Data Form**

## Explosives Handling Review, Stability Review, and Shipping Data Form

Requester_____		Explosive ID and LLNL Lot #_____	
Manufacturer_____			
Manufacturer's designation_____			
DOT reference number_____			
IHC (if applicable) and expiration date_____			
Composition or chemical name_____			
Date manufactured_____		Date received by LLNL_____	
Explosive components and their handling and/or stability review dates_____			
Physical state: (solid/liquid, m.p., b.p., etc.)_____			
Stability:	Color	_____	
	Mfg.'s recommended shelf life	_____	
	DSC exotherms (attach curves)	_____	
	Chem. Reactivity Test (CRT)	_____ cm <sup>3</sup> /g @ _____ °C for _____ hr.	
Sensitivity:	Impact, 2.5 kg	Type 12	Type 12B
	Sample	_____	
	Control	_____	
	Spark	_____	
Precautions:	Friction	_____	
	Other	_____	
	Toxicity	_____	
	Compatibility	_____	
	Protective equipment	_____	
	Other	_____	
UNO Hazard Class/Division_____		SC/HC Group_____	
ASSIGNED HANDLING REVIEW DATE			
ASSIGNED STABILITY REVIEW DATE			
Approved: (Explosives Safety Committee Peer Review)		Hazards Control Explosives Safety Group	
Date		Date	
1. _____		_____	
2. _____		_____	
3. _____		_____	
Distribute copies to:			
• Bldg. 827, Site 300		• Energetic Materials Section	
• Hazards Control Explosives Safety		• Consignor	
• Site 300 Controlled Materials Group			